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COMPLETE SPECIFICATION.

## Improvements in and relating to Pump and Motor Combinations.

We, HAYWARD TYLER & CO. LIMITED, a British Company, of Crawley Green Road, Luton, in the County of Bedford, VICTOR IVANOFF, a British Subject, and RALPH EDWARD KING, a British Subject, both of the Company's address aforesaid, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to pump and motor combinations. The object of the invention is the provision of improvements in pump and motor combinations and the invention consists broadly of a pump and motor combination in which the pump is adapted to pump fluid which independently of the operation of the pump may be of high pressure relative to the ambient pressure, and in which the rotor of the pump and the rotor of the motor are mounted on a common shaft, and the pump, motor and shaft are enclosed in a common casing to which the fluid being pumped has access, wherein said common casing comprises three separate parts, viz. a motor-end part and a pump-end part each in the general form of a pot or dome, and a middle part connected intermediate between said two end parts to complete said common casing, and the pump stator is mounted on said middle part, so that the pump-end part can be removed from said middle part leaving the pump stator in place on said middle part.

In order that the invention may be the more clearly understood a pump and motor combination in accordance therewith will now be described reference being made to the accompanying drawings wherein:—

Figures 1A and 1B together constitute a sectional elevation of the pump and motor combination;

[*Price 2s. 8d.*]

Figure 2 is a fragmentary view to a larger scale of an alternative to a portion of Figure 1;

Figure 3 is a similar view to Figure 2 illustrating another alternative.

Referring to the drawings the rotor 1*a* of the motor and the rotor 2*a* of the pump are mounted on a common shaft, 3*a*, 3*b* and the motor casing A and pump casing C are united, by means of a reduced neck portion B between them, into what is essentially a single casing, the said common shaft 3*a*, 3*b* running through this reduced neck portion. The liquid which is being pumped, and which flows through the pump casing C, is able to pass through said reduced neck portion B into the motor casing A, and thus the motor, which is a submersible motor, runs in liquid whose pressure is of the same order as that being pumped by the pump. As the pump is used for boiler circulation this pressure may be very high.

In the present arrangement the aforesaid single casing is made in three integral parts, viz. a middle part 4 and two end parts 5 and 6. The middle part 4 includes the reduced neck portion B together with a relatively small portion of the motor casing A at one end and a relatively small portion of the pump casing C at the other end. One (5) of the end parts, hereinafter called the motor-end part, forms the remainder of the motor casing A and the other end part 6, hereinafter called the pump-end part, forms the remainder of the pump casing C. It will be seen that the middle part 4 is in the form of a tubular neck with outwardly flared ends and that the two end parts 5 and 6 are in the form of pots or elongated domes. These end parts 5 and 6 are bolted by means of bolts 7 and 8 to the outwardly flared ends of the middle part 4 to complete the motor and pump casing. The tubular neck of the middle part is formed externally

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with annular fins or vanes 9 for heat dissipation, since the liquid being pumped may be very hot and it is desirable to keep the motor cool.

The pump inlet 10 and the pump outlet 11 pass through the walls of the pump-end part 6, but the pump stator 2*b* is not mounted directly on said pump-end part 6 but is mounted on the adjacent end of the middle part 4. Said pump stator 2*b* thus comprises what is essentially an inner pump casing 12 in which are mounted the stator elements of the pump and in which the rotor elements rotate. This inner pump casing 12 which does not have to support a large pressure difference on the two sides of its walls can be of light construction.

In like manner the motor stator 1*b* is not mounted directly on the motor-end part 5 but is mounted on the adjacent end of the middle part 4. Said motor stator comprises a relatively light shell 13 which encases the stator windings 14, and it is this shell which is mounted on the end of the middle part 4. Liquid flows freely into this shell and also flows freely into the clearance between the outside of said shell and the inside of the main outer casing, and thus said shell 13, like the inner pump casing 12, does not withstand pressure difference and can be of light construction.

It will thus be seen that the massive pump-end part 6 and motor-end part 5 merely serve as pressure-resisting covers and can be removed and replaced without interfering with the motor and pump stators or with the common rotating assembly. Thus the necessity for accurate relative positioning of the middle part 4, the pump-end part 6 and the motor-end part 5 is obviated, and, as a result, much of the internal machining is avoided. Also the fitting of the motor and pump is enabled to take place under conditions of easy access, with the motor-end part 5 and the pump-end part 6 out of the way.

More particularly the middle part 4, at its end which is bolted to the pump-end part 6, is formed with an annular sleeve-like projection 15 which projects into the pump-end part 6 just inside the inner periphery thereof. Near the extremity of said sleeve-like projection 15, so-called "piston rings" 16 are provided between the outer periphery of said sleeve-like projection and the inner periphery of the pump-end part 6. An alternative possibility would be to use self sealing packing of the kind expanded by the liquid pressure. In either case a liquid-tight seal is constituted. The inner pump casing 12, which is of generally cylindrical form, is formed with an annular flange 17 running circumferentially round its outer periphery about mid way of its length, and this is bolted flush against the extremity of said sleeve-like projection 15. The end of the inner pump casing 12 which extends into said sleeve-like projection 15 is also bolted against an annular shoulder 18 formed in the inner periphery of the middle part 4. This end of said inner pump casing is closed except for a plurality of small holes 19, and thus it permits of a slow flow of liquid from the pump casing through the reduced neck portion to the motor casing as before stated.

It will be seen that the annular flange 17 around the inner pump casing 12, together with the piston rings 16 round the sleeve-like projection 15, separates into two parts the space surrounding said inner pump casing 12. The inlet 20 to the inner pump casing is at the extremity thereof remote from the middle part 4, and is therefore on one side of said annular flange 17. The outlet 21 from said inner pump casing 12 is near the other end thereof and is therefore on the other side of said annular flange 17. The inlet 10 and outlet 11 to and from the pump-end part pass as before stated through the wall of said pump-end part 6, the inlet 10 being on said one side of the flange 17 and piston rings 16, and the outlet port 11 being on said other side of said flange 17 and piston rings 16. Thus the liquid flows first into said pump-end part by way of said inlet 10, then into the inlet 20 of the inner pump casing, then out of the outlet 21 of said inner pump casing and finally through a port 22 in said sleeve-like projection 15 out of the pump-end part by way of said outlet 11.

The shell 13 of the motor stator is of generally cylindrical form and has a flange 23 round one end which is bolted to an annular shoulder 24 formed in the inner periphery of said middle part 4. Both ends of said cylindrical shell 13 are sufficiently open to permit liquid to flow through them.

The electrical leads 25 by which the stator windings of the motor are supplied pass through and are anchored in said middle part 4. Owing to the fact that the openings in the wall of said middle part through which said leads are inserted from inside is covered by the motor in its assembled position the conductors 26 leading from the motor to said leads 25 are made relatively long. During assembly the stator 1*b* is suspended some distance above said middle part 4 (which is located vertically) and the leads 25 are placed in position in their openings and are fastened, and then the stator 1*b* is lowered slowly, being at the same time rotated so as to arrange the conductors 26 in a spiral manner within the flared end of said middle part 4 beneath the aforesaid shoulder 24 to which the stator shell 13 is bolted.

Within the neck portion B of the casing there is provided a sleeve 27 through which

the common shaft 3*a*, 3*b* passes. This sleeve 27, which is formed with a number of annular vanes 28 to provide baffle means to check heat transfer through the liquid from the pump to the motor is loose around the shaft 3*a*, 3*b*. At its end nearest the pump it is rigidly secured to the middle part 4 by means of screws 29, and, at its end nearest the motor, it is formed with longitudinal flutes 30 which engage the inner periphery of the neck portion B and ensure correct centering. The sleeve proper at this latter end is also, as clearly shown, of increased diameter. The sleeve 27 is more particularly described in the Specification of co-pending Application No. 27952/49 (Serial No. 701,510) of even date herewith, and will not be further described in the present Specification. The shaft 3*a*, 3*b* runs in two bearings 31 and 32 one of which (31) is mounted in said enlarged portion of the sleeve 27 and the other of which (32) is mounted within the shell 13 of the motor stator at the end remote from the middle part 4 of the casing. These bearings 31 and 32 are of the tilting-pad type and are more particularly described in the Specification of co-pending Application No. 27949 (Serial No. 701,508) of even date herewith.

In view of the fact that the pump 2*a*, 2*b* and the common casing 4, 5, 6 on the one hand may be manufactured from materials having a different electrochemical potential from the materials used in the construction of the motor 1*a*, 1*b* on the other hand, it is desirable to provide electrical insulation between the motor and the remainder of the assembly. Accordingly insulating material 33 is interposed between the aforesaid flange 23 of the shell 13 of the motor stator and the annular shoulder 24 of the middle part 4 of the casing. Insulation 34 must, of course, also be provided round the fastening studs or set screws 35 by which the bolting of said flange 23 to said shoulder 24 is effected.

For the same reason the common shaft 3*a*, 3*b* is made in two pieces 3*a* and 3*b*, one for the motor and one for the pump, and said two pieces are united by an insulating connection. This connection is a spigot and socket connection, the ends of both shaft pieces being reduced to form spigots 36, 37, and said spigots being inserted into the two ends of a socket sleeve or intermediate connecting piece 38 to which they are both fixed. Thus the spigot 37 of one shaft piece (say the pump shaft piece) has an insulating washer 39 slipped over it so as to abut against the shoulder formed at the root end thereof, and an insulating tube 40 is mounted on said spigot so as to abut at one end against said washer, said tube having an interference fit with said spigot. The insulation is then machined on the outside so as to make it concentric with the shaft and to give it the exact dimensions required. The spigot has, at its extremity, a still further reduced and screw threaded portion 41 which projects beyond the insulating tube 40. The socket sleeve 38 is machined with an internal annular flange 42 about mid way of its length projecting inwardly from its inner periphery.

This socket sleeve is heated and slipped over the insulation covered spigot 37 until its end abuts against the said insulating washer 39. This brings the internal annular flange 42 past the extremity of the screw threaded reduced portion 41 of the spigot, and fairly close to, but short of, the shoulder at the root end of said screw threaded reduced portion.

A second insulating washer 43 is now slipped over said screw threaded reduced portion, and a slotted nut 44 is then screwed onto said screw threaded reduced portion and screwed up tight, thereby forcing the socket sleeve hard up against the insulating washer 39. After the nut is screwed up tight, it is fixed to the screw threaded reduced portion by welding at 45.

A diametrical hole is now bored jointly through the socket sleeve 38, the insulating tube 40 and the spigot 37, and a small insulating tube or bush 46 is pressed into this hole. A pin 47 is then pressed through said tube or bush, and the end of said pin is welded to the socket sleeve 38. Finally the spigot 36 of the motor shaft piece 3*a* is inserted into said socket sleeve 38 and is fixed to said socket sleeve by welding at 48. It will be seen that the two shaft pieces are now rigidly secured together but are electrically insulated from each other.

It will be seen that the spigot 37 of the pump shaft piece 3*b* is not actually integral with said pump shaft piece but is formed on a separate part of specially hardened steel welded at 49 to said pump shaft piece 3*b*

Alternatively as in Figure 2 the end of the motor shaft piece 3*a* could be bored and the corresponding end of the socket sleeve 38 reduced to form a spigot 50, and the end of said motor shaft fitted outside said spigot 50, the two parts being welded together at 51. This has the advantage that the end of the motor shaft could be easily heated and shrunk on the reduced end of the socket sleeve. The lower portion of Figure 2 shows more clearly than Figure 1 the connection of the sleeve 38 to the spigot 37.

In an alternative construction reliance is placed on interference fit between the two portions of the shaft as illustrated in Figure 3. For this purpose an insulating sleeve 52 is first pressed on the motor shaft spigot 36 and reduced by grinding to a small thickness. The pump shaft piece 3*b* has a hollow

socket 53 whose internal diameter is somewhat smaller than the final external diameter of the insulating sleeve 52. The hollow socket 53 is expanded by heating and shrunk on the insulating sleeve 52. An insulating disc 54 may first be placed inside the socket to prevent contact between the end of spigot and the socket.

It may be mentioned that the electrical insulation interposed between the two shaft pieces 3*a* and 3*b* also serves to reduce the flow of heat along the shaft from the pump to the bearing within the aforesaid loosely fitting sleeve 27 (which is on the side of the insulation remote from the pump) and to the motor.

The end thrust of the common shaft 3*a*, 3*b* is taken by an end thrust bearing 55 of the tilting-pad type mounted just above the journal bearing 32, and just above said end thrust bearing 55 is a small impeller 56. By means of this impeller 56 the liquid in the motor casing A is kept in a continuous state of circulation through an external cooling device, and thus the motor is kept relatively cool. The liquid thus circulated flows from the external cooling device into the top of the motor casing by way of a conduit 57 and then flows through the impeller 56 and down through the stator of the motor into the reduced neck portion B and thence by way of pipe 58 to the external cooling device.

Describing now certain constructional details, the shell 13 of the motor stator has its lower end covered by means of a plate 59 and its upper end covered by means of a plate 60. A light inner tube 61 surrounding the common shaft extends between the said plates 59 and 60, and thus the shell 13, the plates 59 and 60 and inner tube 61 form an enclosure for the stator windings 14. The plate 59 has holes 62 through it which afford liquid communication to this enclosure and the plate 60 has holes 63 which also afford liquid communication to said enclosure.

The housing of the bearing 32 is mounted in the plate 60 as clearly shown, said housing being formed with a flange 64 which overlies said plate 60.

Mounted on said flange 64 is a disc ring 65 and mounted on said disc ring are the tilting pads 66 of the tilting pad bearing 55. These tilting pads 66 are located by means of screw pegs 67 screwed into said disc ring 65.

The rotating element of the tilting pad bearing is constituted by a disc 68 mounted fast on the shaft and having secured on its under surface a layer 69 of synthetic resin material whose under surface makes sliding contact with the tilting pads. This material 69 is made fast by pegs 70. It may be a material of the phenol formaldehyde type.

Mounted on the plate 60 is an annular upright wall 71 surrounding the tilting pad bearing 55, and mounted on the top of this wall is a horizontal plate 72 having a central opening through which passes a nut 73 screwed on the top of the shaft and serving to secure the disc 68 in place. A clearance 74 remains between the nut 73 and the edge of the hole in the plate 72.

The vanes of the impeller 56 are constituted by raised ridges 75 formed on the upper surface of the disc 68, the upper surfaces of which ridges are very closely adjacent the under surface of the plate 72. When the shaft is rotating liquid is drawn from the top of the casing down through the clearance 74 and is thrown out radially by the vanes 75 into the space within the wall 71 from which it passes down through the holes 63 to the stator windings.

Between the top of the pump stator and the lower end of the sleeve 27 is a space in which are provided a plurality of spaced disc-shaped baffles 76 mounted on a sleeve 77 which surrounds the shaft with a clearance in between and is welded at its lower end to the top of the pump stator. Spacing elements 78 on the sleeve 77 serve to locate the baffles 76, and the sleeve 77 together with the uppermost spacing element 78 projects into a counter-sunk space surrounding the shaft in the lower end of the sleeve 27. In this space, above the sleeve 77 is a sludge gland 79. The baffles 76 are in accordance with prior Specification No. 595,956, and the sludge gland 79 is described more particularly in our co-pending Application No. 27950/49 (Serial No. 701,509) of even date herewith.

The path by which the liquid being pumped is free to flow to the motor may be traced from the pump outlet, through the clearance between the sleeve 77 and the shaft to and through the sludge gland 79 into the clearance between the sleeve 27 and the shaft. From there the path divides, one branch being traced through said last-named clearance and through the bearing elements of the bearing 31 to the motor casing, and the other path being traced through a port 80 in the sleeve and over the outside of said sleeve and between the flutes 30 to the motor casing.

Within the motor casing the liquid has access through the holes 62 into the enclosure of the stator windings and through the holes 63 and the clearance 74 to the outside of the shell 13. The liquid also clearly has access to the space inside the inner tube 61.

The circulation path through the external cooling device may be traced from said cooling device through the conduit 57 to the top of the motor casing, then through the impeller 56 as before described to the enclosure

of the stator windings 14, then through the holes 62 to the outside of the sleeve 27 and through the conduit 58 to the cooling device.

Certain features and characteristics of the circulation and air venting system are as described and claimed in co-pending Application No. 27948/49 (Serial No. 701,507) of even date herewith.

We are aware that Patent No. 544,930 covers a system comprising a pump driven by an electric motor and in which the fluid being pumped is, independently of the action of the pump, of high pressure relative to the ambient pressure surrounding the pump casing, wherein the motor is immersed in fluid contained in what is in effect a part or extension of the pump casing and whose pressure is the same, or is of the same order, as the pressure of said fluid being pumped, so that the transmission between said motor and said pump does not require any bearing, stuffing box or the like capable of withstanding high differential pressure on its two sides.

What we claim is:—

1. A pump and motor combination in which the pump is adapted to pump fluid which independently of the operation of the pump may be of high pressure relative to the ambient pressure, and in which the rotor of the pump and the rotor of the motor are mounted on a common shaft, and the pump, motor and shaft and enclosed in a common casing to which the fluid being pumped has access, wherein said common casing comprises three separate parts, viz. a motor-end part and a pump-end part each in the general form of a pot or dome, and a middle part connected intermediate between said tow end parts to complete said common casing, and the pump stator is mounted on said middle part, so that the pump-end part can be removed from said middle part leaving the pump stator in place on said middle part.

2. A combination according to Claim 1, and in which said common casing comprises a reduced neck portion between the pump casing and the motor casing, through which reduced neck portion the common shaft passes, wherein said middle part comprises the reduced neck portion together with a portion of the pump casing at one end and a portion of the motor casing at the other end.

3. A combination according to Claim 2, wherein said reduced neck portion is provided with external vanes for heat dissipation.

4. A combination according to any of the preceding claims, wherein the said three separate parts are of massive construction so as to be capable of resisting said high pressure.

5. A combination according to Claim 4, wherein the pump stator consists of an inner pump casing and is of relatively light construction.

6. A combination according to Claim 5, wherein an annular seal is formed between the outer periphery of said inner pump casing and the inner periphery of the pump-end part, the inlet and outlet of said inner pump casing being on opposite sides of said seal and inlet and outlet ports also on opposite sides of said seal being formed through the wall of the pump-end part.

7. A combination according to Claim 5 or 6, wherein a perforated sleeve integral with the middle part extends into the pump-end part between the inner periphery of said pump-end part and the outer periphery of said inner pump casing, and said inner pump casing is bolted to the end of said sleeve.

8. A combination according to Claim 7 in combination with Claim 6, wherein said annular seal is formed at the region of the end of said sleeve.

9. A combination according to any of the preceding claims, wherein the motor stator is mounted on the middle part, so that the motor-end part can be removed from said middle part leaving the motor stator mounted *in situ* on said middle part.

10. A combination according to Claim 9 in combination with Claim 4, wherein said motor stator comprises a relatively light shell which encases the stator windings and to both the inside and the outside of which the high pressure fluid is admitted, and said relatively light shell is mounted on said middle part.

11. A combination according to Claim 9 or 10, wherein the electrical leads by which the motor is supplied pass through and are anchored in the wall of said middle part.

12. A combination according to Claim 13, wherein the conductors leading from said leads to the stator of the motor are relatively long, enabling said stator, during assembly, to be suspended above said middle part while said leads are being anchored in the wall of said middle part, and subsequently lowered and bolted to said middle part.

13. A combination according to any of the preceding claims, wherein the common shaft is surrounded by a sleeve element mounted in the middle part, said sleeve element being loose on said shaft and being provided on its outside with baffle means for checking the transfer of heat from the pump to the motor by way of the fluid surrounding the common shaft.

14. A combination according to Claim 13, wherein at one end the bore of said sleeve is enlarged, and a bearing for said common shaft is mounted in the enlarged portion of said sleeve.

15. A combination according to Claim 10, wherein said common shaft runs in a bearing mounted on the shell of the motor stator.

16. A combination according to any of the preceding claims, and in which the pump and the common casing on the one hand and the motor on the other hand are made from materials having different electro-chemical potentials, wherein electrical insulating material is provided between said motor and said pump and common casing.

17. A combination according to Claim 16 in combination with Claim 9, wherein insulating material is associated with the means by which the motor stator is mounted on the middle part, so that said motor stator is insulated from said middle part, and wherein said mommon shaft comprises two parts rigidly connected together, viz. a motor shaft part and a pump shaft part, and insulating material is associated with the means for connecting said two shaft parts together so that said two shaft parts are insulated from each other.

18. A combination according to Claim 17, wherein said two shaft parts are connected together by means of an intermediate connecting piece which makes spigot and socket connections with the respective shaft parts, one of said spigot and socket connections being made fast by welding, and the other having associated insulation for insulating the intermediate connecting piece from the respective shaft part.

19. A combination according to Claim 18, wherein the spigot and socket connection which has associated insulation is made fast by means of a pin passed through a hole drilled through both the socket and the spigot, insulation being provided to prevent said pin electrically connecting said socket and spigot.

20. A combination according to Claim 19, wherein screw means are provided for drawing the spigot and socket tight into each other before said spigot and socket are drilled and said pin is passed through.

21. A combination according to Claim 17, wherein said two shaft parts are connected together by making a spigot and socket connection with each other, insulation being provided to insulate the spigot from the socket.

22. A combination according to Claim 21, wherein the socket is heated and shrunk on to the spigot.

23. A pump and motor combination substantially as herein described with reference to the accompanying drawings.

A. A. THORNTON & CO.,
Chartered Patent Agents,
Napier House, 24—27 High Holborn,
London, W.C.1.
For the Applicants.

## PROVISIONAL SPECIFICATION.

## Improvements in and relating to Pump and Motor Combinations.

We, HAYWARD TYLER & CO. LIMITED, a British Company, of Crawley Green Road, Luton, in the County of Bedford, VICTOR IVANOFF, a British Subject, and RALPH EDWARD KING, a British Subject, both of the Company's address aforesaid, do hereby declare the nature of this invention to be as follows:—

This invention relates to pump and motor combinations. The object of the invention is the provision of improvements in pump and motor combinations and the nature of the invention will be understood from the following description of one embodiment thereof.

In accordance with this embodiment, the rotor of the motor and the rotor of the pump are mounted on a common shaft, and the motor casing and pump casing are united, by means of a reduced neck portion between them, into what is essentially a single casing, the said common shaft running through this reduced neck portion. The liquid which is being pumped, and which flows through the pump casing, is able to pass through said reduced neck portion into the motor casing, and thus the motor, which is a submersible motor, runs in liquid whose pressure is of the same order as that being pumped by the pump. As the pump is used for boiler circulation this pressure may be very high.

In the present arrangement the aforesaid single casing is made in three integral parts, viz. a middle part and two end parts. The middle part includes the reduced neck portion together with a relatively small portion of the motor casing at one end and a relatively small portion of the pump casing at the other end. One of the end parts, hereinafter called the motor-end part, forms the remainder of the motor casing and the other end part, hereinafter called the pump-end part, forms the remainder of the pump casing. It will be seen that the middle part is in the form of a tubular neck with outwardly flared ends and that the two end parts are in the form of elongated domes. These end parts are bolted to the outwardly flared ends of the middle part to complete

the motor and pump casings. The tubular neck of the middle part is formed externally with annular fins for heat dissipation, since the liquid being pumped may be very hot and it is desirable to keep the motor cool.

The pump inlet and the pump outlet pass through the wall of the pump-end part, but the pump stator is not mounted directly on said pump-end part but is mounted on the adjacent end of the middle part. Said pump stator thus comprises what is essentially an inner pump casing in which are mounted the stator elements of the pump and in which the rotor elements rotate. This inner pump casing which does not have to support a large pressure difference on the two sides of its walls can be of light construction.

In like manner the motor stator is not mounted directly on the motor-end part but is mounted on the adjacent end of the middle part. Said motor stator comprises a relatively light shell which encases the stator windings, and it is this shell which is mounted on the end of the middle part. Liquid flows freely into this shell and also flows freely into the clearance between the outside of said shell and the inside of the main outer casing, and thus said shell, like the inner pump casing, does not withstand pressure difference and can be of light construction.

It will thus be seen that the massive pump-end part and motor-end part merely serve as pressure-resisting covers and can be removed and replaced without interfering with the motor and pump stators or with the common rotating assembly. Thus the necessity for accurate relative positioning of the middle part, the pump-end part and the motor-end part is obviated, and, as a result, much of the internal machining is avoided. Also the fitting of the motor and pump is enabled to take place under conditions of easy access, with the motor-end part and the pump-end part out of the way.

More particularly the middle part, at its end which is bolted to the pump-end part, is formed with an annular sleeve-like projection which projects into the pump-end part just inside the inner periphery thereof. Near the extremity of said sleeve-like projection, so-called "piston rings" are provided between the outer periphery of said sleeve-like projection and the inner periphery of the pump-end part. An alternative possibility would be to use self sealing packing of the kind expanded by the liquid pressure. In either case a liquid-tight seal is constituted. The inner pump casing, which is of generally cylindrical form, is formed with an annular flange running circumferentially round its outer periphery about mid way of its length, and this is bolted flush against the extremity of said sleeve-like projection. The end of the inner pump casing which extends into said sleeve-like projection is also bolted against an annular shoulder formed in the inner periphery of the middle part. This end of said inner pump casing is closed except for a plurality of small holes, and thus it permits of a slow flow of liquid from the pump casing through the reduced neck portion to the motor casing as before stated.

It will be seen that the annular flange around the inner pump casing, together with the piston rings round the sleeve-like projection, separates into two parts the space surrounding said inner pump casing. The inlet to the inner pump casing is at the extremity thereof remote from the middle part, and is therefore on one side of said annular flange. The outlet from said inner pump casing is near the other end thereof and is therefore on the other side of said annular flange. The inlet and outlet to and from the pump-end part are by way of ports in the wall of said pump-end part, the inlet port being on said one side of said flange, and the outlet port being on said other side of said flange. Thus the liquid flows first into said pump-end part by way of said inlet port, then into the inlet of the inner pump casing, then out of the outlet of said inner pump casing and finally through a port in said sleeve-like projection out of the pump-end part by way of said outlet port.

The shell of the motor stator is of generally cylindrical form and has a flange round one end which is bolted to an annular shoulder formed in the inner periphery of said middle part. Both ends of said cylindrical shell are sufficiently open to permit liquid to flow through them.

The electrical terminals to which the stator windings of the motor are connected are anchored in said middle part. Owing to the fact that the opening in the wall of said middle part through which said terminals are inserted from inside is covered by the motor in its assembled position the conductors leading from the motor to said terminals are made relatively long. During assembly the stator is suspended some distance above said middle part (which is located vertically) and the terminals are placed in position in said opening and are fastened, and then the stator is lowered slowly, being at the same time rotated so as to arrange the conductors in a spiral manner within the flared end of said middle part beneath the aforesaid shoulder to which the stator shell is bolted.

Within the neck portion of the casing there is provided a loosely fitting sleeve through which the common shaft passes. This loosely fitting sleeve is more particularly described in the Specification of co-pending Application No. 27952/49 (Serial

No. 701,510) of even date herewith, and will not be further described in the present Specification. The shaft runs in two bearings one of which is in said loosely fitting sleeve and the other of which is mounted within the shell of the motor stator near the end remote from the middle part of the casing. These bearings are more particularly described in the Specification of co-pending Application No. 27946/49 (Serial No. 701,508) of even date herewith.

In view of the fact that the pump and the common casing on the one hand may be manufactured from materials having a different electrochemical potential from the materials used in the construction of the motor on the other hand, it is desirable to provide electrical insulation between the motor and the remainder of the assembly. Accordingly insulating material is interposed between the aforesaid flange of the shell of the motor stator and the annular shoulder of the middle part of the casing to which said flange is bolted. Insulation must, of course, also be provided round the fastening studs or set screws by which the bolting of said flange to said shoulder is effected.

For the same reason the common shaft is made in two pieces, one for the motor and one for the pump, and said two pieces are united by an insulating connection. This connection is a spigot and socket connection, the ends of both shaft pieces being reduced to form spigots, and said spigots being inserted into the two ends of a socket sleeve to which they are both fixed. Thus the spigot of one shaft piece (say the pump shaft piece) has an insulating washer slipped over it so as to abut against the shoulder formed at the root end thereof, and an insulating tube is mounted on said spigot so as to abut at one end against said washer, said tube having an interference fit with said spigot. The insulation is then machined on the outside so as to make it concentric with the shaft and to give it the exact dimensions required. The spigot has, at its extremity, a still further reduced and screw threaded portion which projects beyond the insulating tube. The socket sleeve is machined with an internal annular flange about mid way of its length projecting inwardly from its inner periphery.

This socket sleeve is heated and slipped over the insulation covered spigot until its end abuts against the said insulating washer. This brings the internal annular flange past the extremity of the screw threaded reduced portion of the spigot, and fairly close to, but short of, the shoulder at the root end of said screw threaded reduced portion.

A second insulating washer is now slipped over said screw threaded reduced portion, and a slotted nut is then screwed onto said screw threaded reduced portion and screwed up tight, thereby forcing the socket sleeve hard up against the first insulating washer. After the nut is screwed up tight, it is fixed to the screw threaded reduced portion by welding.

A diametrical hole is now bored jointly through the socket sleeve, the insulating tube and the spigot, and a small insulating tube or bush is pressed into this hole. A pin is then pressed through said tube or bush, and the end of said pin is welded to the socket sleeve. Finally the spigot of the motor shaft piece is inserted into said socket sleeve and is fixed to said socket sleeve by welding. It will be seen that the two shaft pieces are now rigidly secured together but are electrically insulated from each other.

Alternatively the end of the motor shaft could be bored and the corresponding end of the socket sleeve reduced, and the end of said motor shaft fitted outside the end of the socket sleeve, the two parts being welded together as before. This has the advantage that the end of the motor shaft could be easily heated and shrunk on the reduced end of the socket sleeve.

In an alternative construction reliance is placed on interference fit between the two portions of the shaft. For this purpose an insulating sleeve is first pressed on the motor spigot and reduced by grinding to a small thickness. The pump shaft has a hollow socket whose internal diameter is somewhat smaller than the final external diameter of the insulating sleeve. The hollow socket is expanded by heating and shrunk on the insulating sleeve. An insulating disc may first be placed inside the socket to prevent contact between the end of spigot and the socket.

It may be mentioned that the electrical insulation interposed between the two shaft pieces also serves to reduce the flow of heat along the shaft from the pump to the bearing within the aforesaid loosely fitting sleeve (which is on the side of the insulation remote from the pump) and to the motor.

In practice the construction comprises the filter arrangement described in co-pending Specification No. 27950/49 (Serial No. 701,509); the shaft bearings are as described in co-pending Specification No. 27949/49 (Serial No. 701,508); the air vent-

ing arrangement described in co-pending Specification No. 27948/49 (Serial No. 701,507) is employed, and the construction is used in combination with a cooler as described in co-pending Specification No. 27951/49.

Dated this 1st day of November, 1949.
A. A. THORNTON & CO.,
Chartered Patent Agents,
Napier House, 24—27 High Holborn,
London, W.C.1.
For the Applicants.

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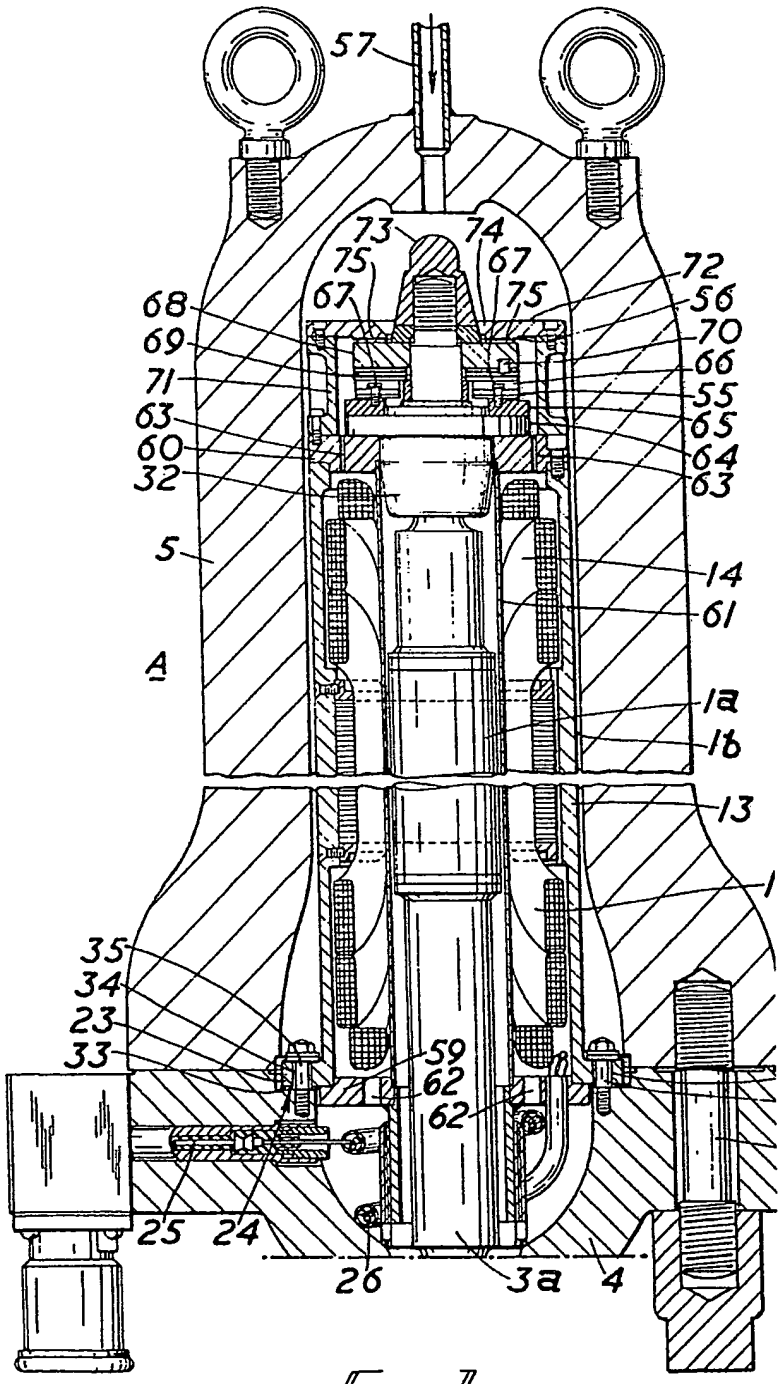
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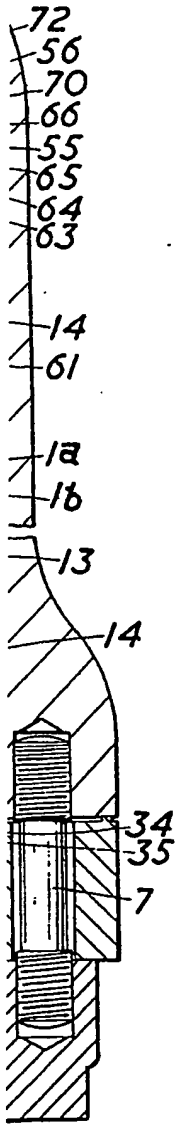
Fig. 1a.

701,511 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale.*

SHEETS 1 & 2



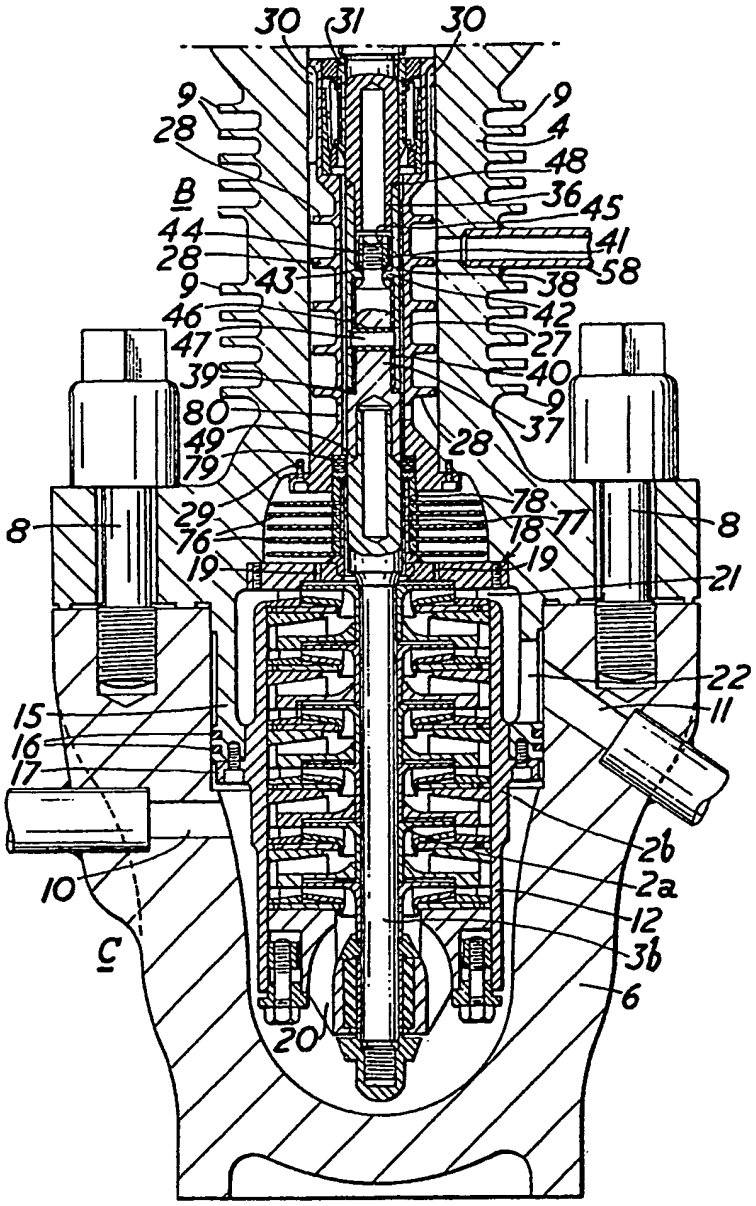




FIG. 1b.

701,511 COMPLETE SPECIFICATION
3 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1 & 2

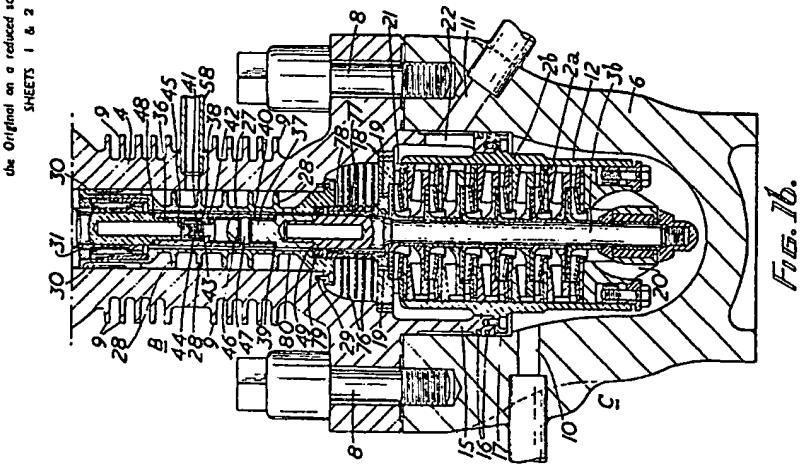


FIG. 1b.

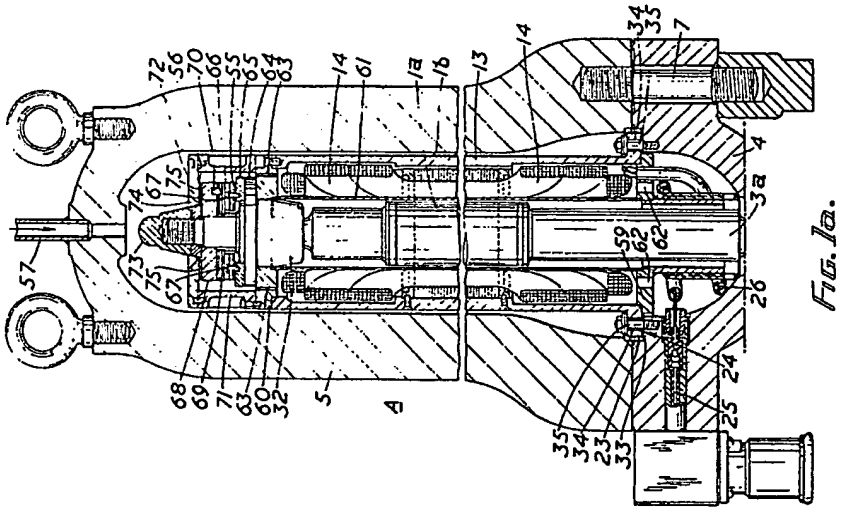


FIG. 1a.

701,511 COMPLETE SPECIFICATION
3 SHEETS
*This drawing is a reproduction of the Original on a reduced scale.*
SHEET 3

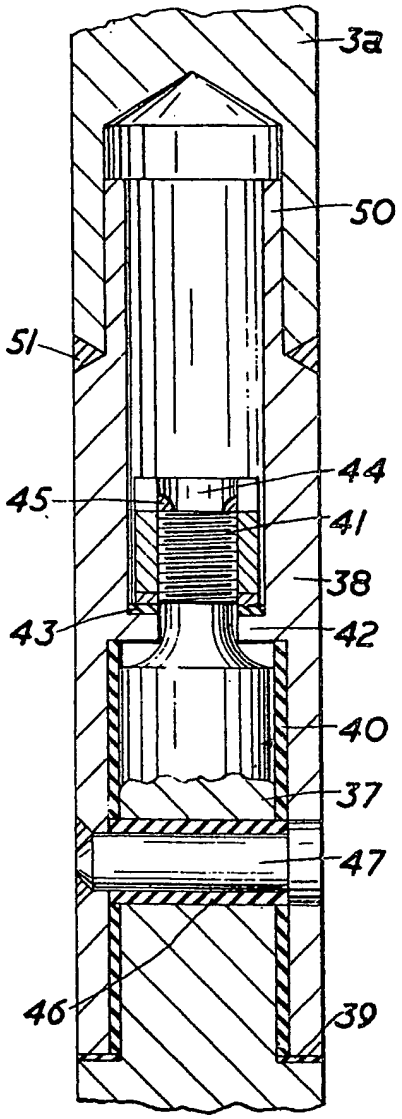



FIG. 2.

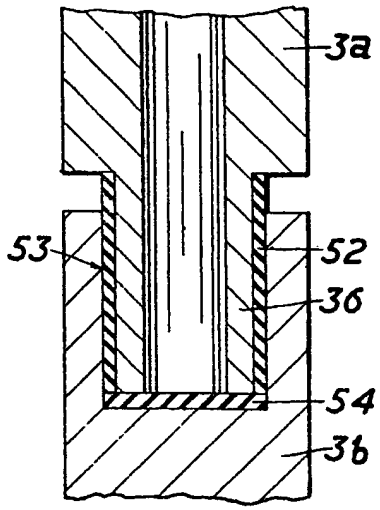



FIG. 3.